Rules of Origin and the Use of NAFTA

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Setting and Research Questions

- Firms can choose whether to export using the FTA or WTO membership
- Rules of Origin are the criteria needed to determine if an export can use an FTA
  - In NAFTA, certain inputs have to be sourced from North America
- Tradeoff between lower sourcing efficiency and lower barriers to trade
- **How do Rules of Origin affect the use of a Free Trade Agreement?**
- **What are their implications for bilateral trade flows?**

Motivation

- 50.8% of global trade flows occur between members of Free Trade Agreements
- 360 active FTAs around the world; at least 62% contain Rules of Origin
- Scarce evidence on the use of an FTA and the firm-level effects of RoO
- Need for better-designed trade policies given recent waves of protectionism

Related Literature and Contribution

What this paper does

1. **Data**: Build dataset on firms' use of NAFTA and input sourcing, RoO and tariffs
2. **Empirical evidence**: Document three empirical facts
   - Positive correlation between RoO and tariffs
   - NAFTA usage depends on firm size: inverse u-shape
   - Effect of NAFTA on non-NAFTA sourcing is increasing in firm size
3. **Model**: Build a model of input sourcing with NAFTA and RoO
   - Include fixed costs of using NAFTA and of sourcing from foreign countries
   - Quantify our model by estimating these fixed costs and sourcing attractiveness
4. **Counterfactuals**: Explore the effects of:
   - A 25% increase in RoO $\rightarrow$ 0.72% lower US-CA exports of intermediates
   - A 5% tariff on all Mexican imports $\rightarrow$ 13.65% lower US-CA exports of intermediates
   - A removal of RoO $\rightarrow$ 2.98% higher US-CA exports of intermediates

Empirical Facts

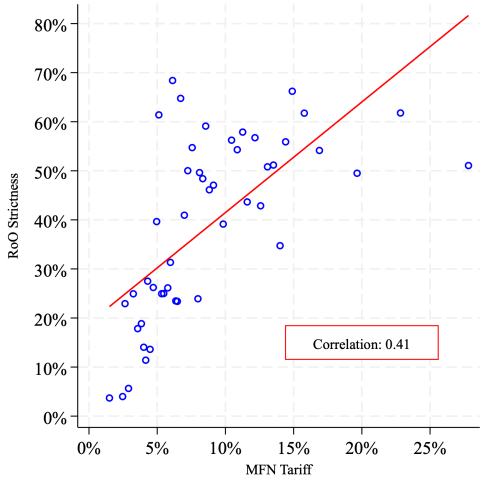
Data sources

1. **Customs** data for Mexico accessed through the country's Central Bank
   - Monthly data for exports of final goods and imports of intermediate goods; **for every transaction we can observe if it used NAFTA or WTO**
2. **IO Tables** from the BEA for 2017
3. **Rules of Origin** data contained in NAFTA's Annex 401
   - We combine these two sources to compute a product-level measure of RoO Strictness
4. **US Tariffs** data from the Harmonized Tariff Schedule, revision 2022
   - We only include products with positive ad-valorem MFN Tariffs

Data sample details

EF1: Positive correlation between RoO and MFN Tariffs

- Tradeoff between using NAFTA and WTO membership
- Sectors in which the benefit of using NAFTA is higher...
- ... are also sectors in which the cost of using NAFTA is larger



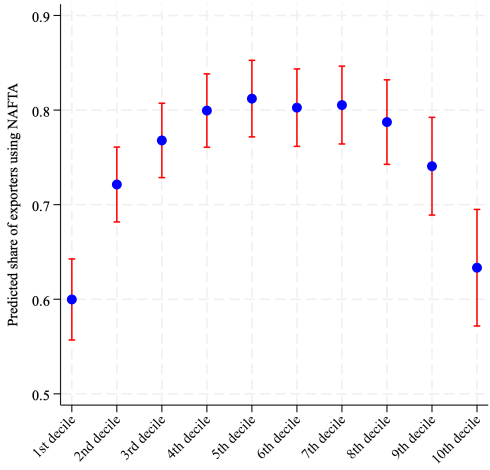
Further details on RoO

EF 2: The smallest and largest firms use NAFTA less intensively

- Probability of using NAFTA to export:

$$\mathbb{N}_{ikjt} = \beta_0 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \alpha_1 \text{ROO}_j + \alpha_2 \text{MFN}_j + \iota_t + \epsilon_{ikjt}$$

- $\mathbb{N}_{ikjt} = 1$ if NAFTA; $\mathbb{I}_{ikt} = 1$ if size k
- Controlling for:
  - ROO_j: share of inputs restricted
  - MFN_j: ad-valorem tariff



Robustness checks

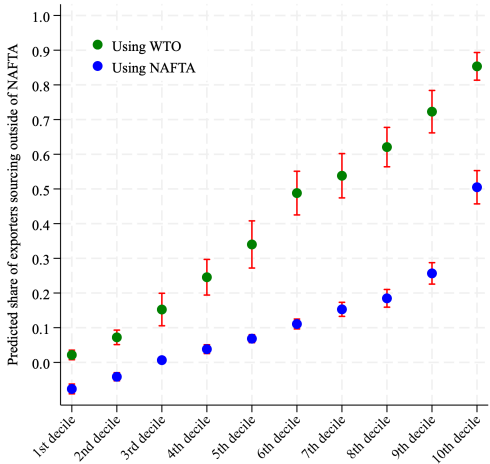
i: firm; k: decile; j: product; t: month; ι: fixed-effects

EF 3: NAFTA has a larger effect on non-NAFTA sourcing for larger firms

- Probability of non-NAFTA sourcing:

$$\mathbb{S}_{ikst} = \beta_0 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \iota_{st} + \epsilon_{ijt}$$

- $\mathbb{S}_{ikjt} = 1$ if non-NAFTA sourcing; $\mathbb{I}_{ikt} = 1$ if size k; ι_{st} industry-year FE
- Separately for either NAFTA or WTO
- Interested in the gap across firm sizes



Robustness checks | Evidence of Fixed Costs

i: firm; k: decile; s: sector; t: month; ι: fixed-effects

Model

Setup

- We extend the model of global sourcing in Antras et al. (2017) to include Rules of Origin and firms choosing to export either using NAFTA or WTO
- We include a set of sectors and industries within these, as in Chor (2010)
- Key ingredients of our model:
  - CES demand and monopolistic competition final-good producers as in Melitz (2003)
  - Exports of final-goods to US-CA, imports of intermediates
  - Firms source a continuum of intermediate inputs $\nu \in [0, 1]$
  - Firms choose from which countries they **can** source their inputs
  - Competitive global suppliers of inputs, following Eaton and Kortum (2002)

Utility maximization

- Individuals in US-CA maximize utility by consuming a numeraire domestic good D and imported Mexican varieties across sectors and industries:

$$U = D^{1-\eta} \prod_{s=1}^{S} \left[\sum_{i=1}^{I_s} \left(\int_{\omega \in \Omega_{si}} q_{si}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma(\epsilon-1)}{\epsilon(\sigma-1)}} \right]^{\frac{\alpha_s \eta \epsilon}{(\epsilon-1)}}$$

subject to the budget constraint:

$$D + \sum_{s=1}^{S} \sum_{i=1}^{I_s} \left(\int_{\omega \in \Omega_{si}} q_{si}(\omega) p_{si}(\omega) d\omega \right) = E$$

- E: total expenditure; η: share of expenditure spent on Mexican imports; σ: elasticity of substitution across varieties; ϵ: elasticity across industries

Demand | s: sector; i: industry

NAFTA and RoO

- To introduce RoO and the use of NAFTA into the model, we define the following:
  1. $\kappa \in \{0, 1\}$ is equal to 1 when exporting using NAFTA
  2. $\lambda \in [0, 1]$ is the share of restricted inputs if exporting using NAFTA
  3. $\tau \in [0, \infty)$ is the ad-valorem tariff if exporting using WTO
  4. $\zeta \in \mathbb{R}^{++}$ is the fixed cost of exporting using NAFTA
  5. $f^j \in \mathbb{R}^{++}$ is the fixed cost of sourcing from country j

Price of intermediate inputs

- $J(\phi, \kappa, \lambda, \tau)$: set of countries from which a firm can source inputs
- N: set of NAFTA countries
- The price firm ϕ pays for input $\nu \in [0, 1]$ given κ and J is:

$$z_{si}(\nu, \kappa, \lambda, J) = \begin{cases} \min\limits_{j \in N \cap J} \{d^j a^j_{si}(\nu) w^j_{si}\} & \text{if } \nu \in [0, \kappa\lambda) \\ \min\limits_{j \in J} \{d^j a^j_{si}(\nu) w^j_{si}\} & \text{if } \nu \in [\kappa\lambda, 1] \end{cases}$$

- If NAFTA is used, RoO could increase the price of inputs

s: sector; i: industry; j: country; $\kappa = 1$: NAFTA

Marginal cost of exporting and producing

- The marginal cost of exporting and producing for a firm with productivity ϕ is:

$$c_{si}(\phi,\kappa,\lambda,\tau,J)=\frac{1+(1-\kappa)\tau}{\phi}\left(\int_0^{\kappa\lambda} z_{si}(\nu)^{1-\rho}d^*\nu+\int_{\kappa\lambda}^{1} z_{si}(\nu)^{1-\rho}d\nu\right)^{1/(1-\rho)}$$

- Assuming a Fréchet distribution for unit-labor costs:

$$c_{si}(\phi)=\frac{1}{\phi}\gamma^{-1/\theta}[1+(1-\kappa)\tau][\kappa\lambda\Psi_{si}(\phi)^{(\rho-1)/\theta}+(1-\kappa\lambda)\Phi_{si}(\phi)^{(\rho-1)/\theta}]^{\frac{1}{1-\rho}}$$

where:

$$\Psi_{si}(\phi)=\sum_{h\in N\cap J} T_{si}^h(d^h w_{si}^h)^{-\theta} \qquad \Phi_{si}(\phi)=\sum_{h\in J} T_{si}^h(d^h w_{si}^h)^{-\theta}$$

Input Shares

s: sector; i: industry; h: country; $\kappa=1$: NAFTA

Firm behavior

- Firm ϕ exporting using κ will choose sourcing strategy J in order to maximize:

$$\Pi_{si}^{\kappa}(\phi,\lambda,\tau) = \max_{I^j\in\{0,1\}_{j=1}^{J}} \pi_{si}(\phi,\kappa,\lambda,\tau,I^1,....,I^J) - w\sum_{j=1}^{J} I^j f_{si}^j(\phi)$$

- Firm ϕ will choose to export using the κ that maximizes its profits:

$$\kappa^* = \arg\max_{\kappa\in\{0,1\}} \{\Pi_{si}^{\kappa}(\phi,\lambda,\tau) - \kappa w\zeta_{si}\}$$

- ζ_{si} is the fixed cost of using NAFTA to export

Profits, Equilibrium and Comparative Statics

s: sector; i: industry; j: country; $\kappa = 1$: NAFTA

Quantifying the Model

Taking our model to the data

- We include 44 industries (HS 2-digits) within 6 sectors:
  - Agriculture and Foods, Minerals and Chemicals, Skins and Textiles, Mining, Manufacturing, and Others
- Firms can only source inputs from 5 different countries/regions:
  - Mexico, US-CA, China, Europe (Top 10), and ROW
- Within a sector, industries are heterogeneous in terms of:
  - RoO Strictness: We average across products within an industry
  - MFN Tariffs: Same as above
  - Sourcing potentials: We estimate these for each industry-country
  - The number of firms in a sector: We take them from the data
- Within an industry, firms are heterogeneous in terms of their productivity

Quantifying our model

- We take the following steps in terms of quantifying our model:

1. Take several parameters from the literature e.g. elasticities and distributional parameters

2. Employ fixed effects regressions to estimate sourcing potentials at the country-industry level

3. Use SMM to estimate at the sectoral level market demand in the US, and fixed costs of using NAFTA and of sourcing from foreign countries

Estimation Details

Counterfactuals

Counterfactuals

1. **Generalized increase in RoO**
2. Increase in tariffs on Mexican imports
3. NAFTA without Rules of Origin

- Counterfactuals: Does US-CA and/or Mexico benefit from the policy?
  - US-CA: Change in exports of inputs to Mexico and the price of Mexican imports
  - Mexico: Change in firm profits

Results for Counterfactuals 2 and 3

Counterfactual 1: Generalized Increase in RoO

- Assume a general increase of 25% in the strictness of RoO
- Change, in percentage terms, in key variables for US-CA and Mexico:

	US-CA Exports of inputs to MX	US-CA Price index for MX imports	MX firm profits
Agriculture and Foods	-0.42	0.27	-0.85
Minerals and Chemicals	-0.08	0.05	-0.24
Skins and Textiles	-2.93	0.24	-1.45
Mining	-0.03	0.06	-0.08
Manufacturing	-0.05	0.05	-0.08
Others	-0.80	0.32	-1.29
Average	-0.72	0.16	-0.67

Counterfactual 1: Generalized Increase in RoO

Three distinct effects on US-CA exports of intermediates to Mexico:

1. **Substitution Effect**: $\uparrow$ RoO $\Rightarrow$ $\uparrow$ Input purchases from US-CA
2. **Scale Effect**: $\uparrow$ RoO $\Rightarrow$ $\downarrow$ Sourcing efficiency $\Rightarrow$ $\uparrow$ Marginal cost $\Rightarrow$ $\downarrow$ Trade
3. **Switching Effect**: $\uparrow$ RoO $\Rightarrow$ $\downarrow$ Use of NAFTA
   - 3.1 $\downarrow$ Compliance with RoO $\Rightarrow$ $\downarrow$ Input purchases from US-CA
   - 3.2 $\downarrow$ Compliance with RoO $\Rightarrow$ $\uparrow$ Sourcing efficiency $\Rightarrow$ $\downarrow$ Marginal cost $\Rightarrow$ $\uparrow$ Trade
   - 3.3 $\downarrow$ Use of NAFTA $\Rightarrow$ $\uparrow$ MFN tariffs $\Rightarrow$ $\uparrow$ Marginal cost $\Rightarrow$ $\downarrow$ Trade

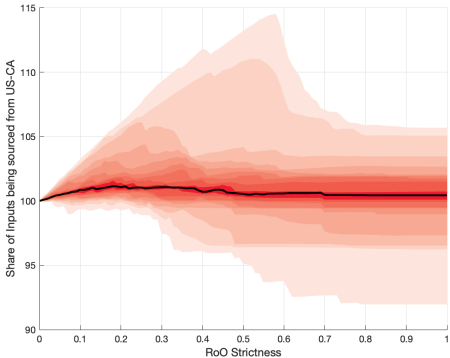
Counterfactual 1: Generalized Increase in RoO

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.02	0.00	0.21	0.77	-
	Change				
Share of firms sourcing from China	5.11	0.00	0.00	-1.04	p.p. Δ
Share of firms sourcing from Europe	11.34	0.00	0.00	-0.41	p.p. Δ
Share of firms sourcing from US-CA	-5.22	0.00	0.00	-0.03	p.p. Δ
Share of firms sourcing from ROW	3.90	0.00	0.00	-1.14	p.p. Δ
Share of inputs coming from US-CA	-8.67	0.00	0.00	0.19	p.p. Δ
Average Marginal Cost	**17.94**	0.00	0.00	**0.22**	% Δ
Average Exports	-7.83	0.00	0.00	-0.15	% Δ

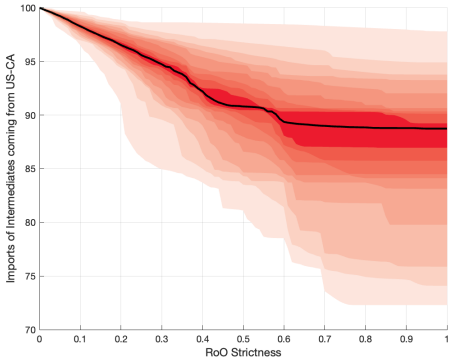
Effects: Substitution, Scale

Share of Inputs and Imports of Intermediates from US-CA

- Is there a RoO that maximizes the share of inputs or the amount of imports?



(a) Share of intermediate inputs from US-CA



(b) Imports of intermediates from US-CA

Conclusions

Conclusions

- Main message: **The use of an FTA depends on firm size**
  - Fixed costs affect the opportunity cost of complying with RoO
- RoO seek to protect local industries $\rightarrow$ stricter in inefficient industries
  - Lower sourcing efficiency $\Rightarrow$ decrease in trade
- RoO seek to increase regional content in bilateral exports
  - A larger share of the pie $\not\Rightarrow$ eating more pie

Thank you!

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Appendix

Related literature and contribution

1. **Impact of Preferential Trade Agreements**: Trefler (2004), Romalis (2007), Arkolakis et al. (2008), Bustos (2011), Ossa (2011), Antràs and Staiger (2012), Kehoe and Ruhl (2013), Caliendo and Parro (2015), De Loecker (2016)

   → **Contribution:** Provide evidence on which firms use NAFTA to export

2. **Rules of Origin and content protection**: Grossman (1981), Dixit and Grossman (1982), Ju and Krishna (2002), Augier et al. (2005), Deardorff (2018), Conconi et al. (2018), Krishna et al. (2022), Ornelas and Turner (2022), Head et al. (2022)

   → **Contribution:** Empirically study the firm-level effects of RoO

3. **Global sourcing decisions**: Antràs and Helpman (2004, 2008), Goldberg et al. (2010), Rodriguez-Clare (2010), Garetto (2013), Kee and Tang (2016), Tintelnot (2017), Antràs et al. (2017), Bernard et al. (2018), Head and Mayer (2019)

   → **Contribution:** Build and quantify a model of input sourcing with an FTA

Back

Data sample

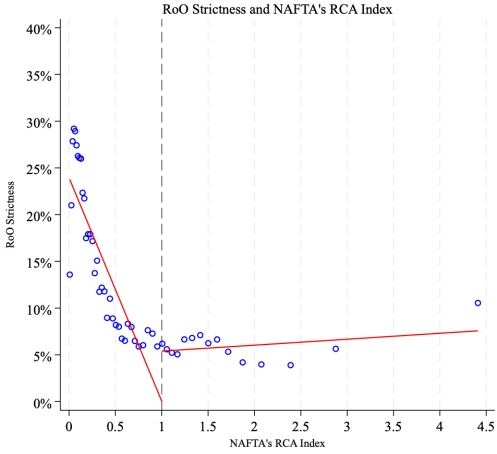
- Observations are between September 2014, when data on NAFTA usage became available, and June 2020, before the introduction of USMCA
- 25,572 firms exporting 1,050 products to the US $\rightarrow$ 1,019,408 unique firm-time-product combinations
- We restrict our sample in the following ways:
  - Keep firms with exports larger than imports $\rightarrow$ 70.73% of firms
  - Keep products with positive ad-valorem MFN tariffs $\rightarrow$ 63.27% of products
  - Keep products for which exporters have to comply with RoO $\rightarrow$ 86.76% of products
- Our sample includes 410 products in 48 different HS 2-digit sectors, and 9,918 unique firms exporting to the US

Back

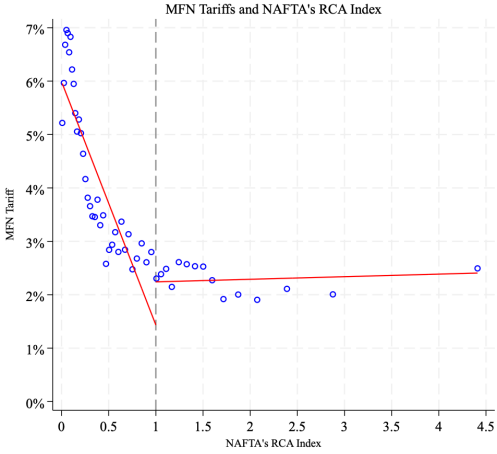
Computing RoO Strictness at the product level

- We compute RoO Strictness at the HS 6-digit level following Conconi et al. (2018); using direct requirement coefficients from the IO Tables and NAFTA's Annex 401 Rules of Origin data
- IO Tables give us information on the input shares each product uses, while NAFTA's Annex 401 records for each product which of its inputs have to be sourced from NAFTA countries
- For example, we know a product uses 40% of input A, 35% of input B, and 25% of input C. We also know that if a firm wants to export this product using NAFTA, inputs A and B have to be sourced from within NAFTA; therefore, the RoO Strictness of this product is 75%

Correlations between RoO, MFN, and RCA



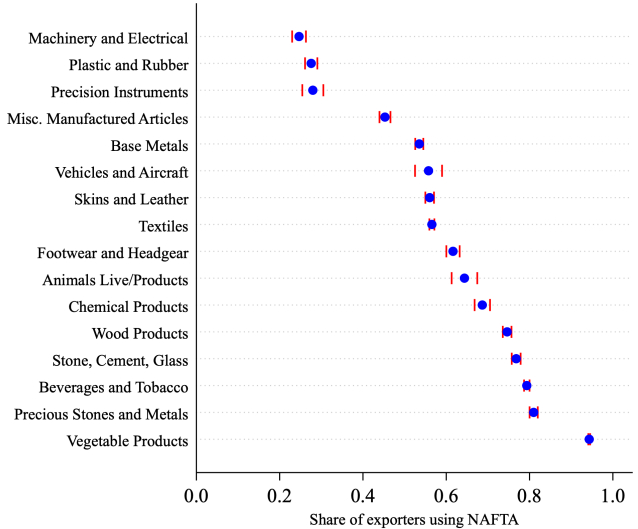
Source: Author's calculations using data from BEA's 1997 IO Tables, NAFTA's Annex 401 and CEPII's BACI database.
Note: By construction there is a discontinuity at 1, where products below 1 are those for which NAFTA has comparative disadvantage, and vice versa.



Source: Author's calculations using data from BEA's 1997 IO Tables, NAFTA's Annex 401 and CEPII's BACI database.
Note: By construction there is a discontinuity at 1, where products below 1 are those for which NAFTA has comparative disadvantage, and vice versa.

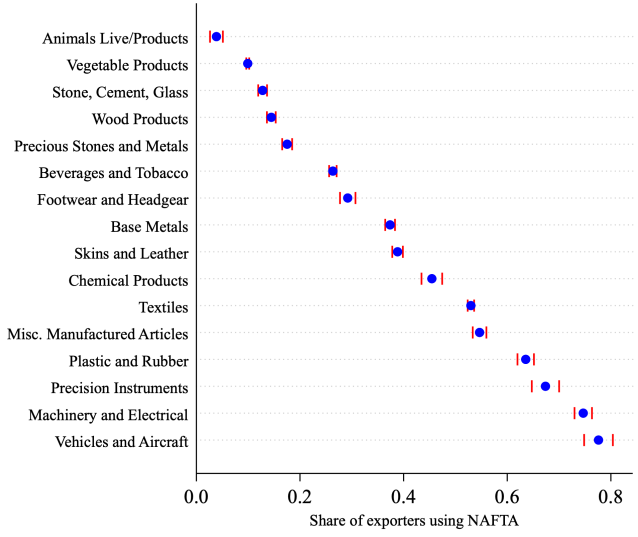
Sectoral heterogeneity in the use of NAFTA

- Heterogeneity in the use of NAFTA could be driven by:
  - Differences in MFN Tariffs and RoO
  - Differences in the fixed cost of using NAFTA



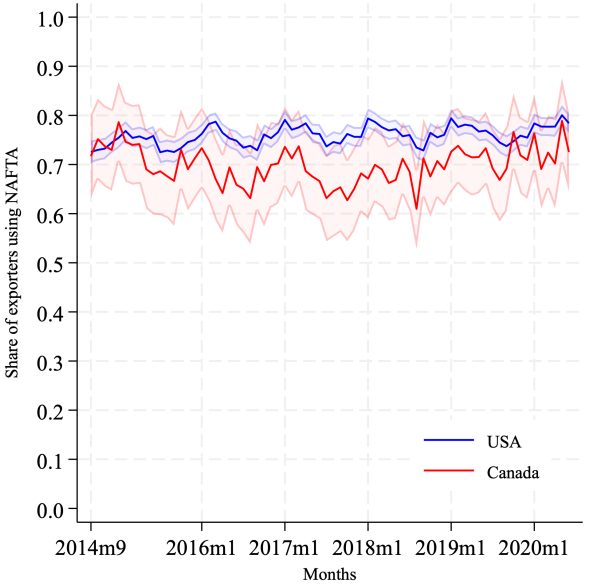
Sectoral heterogeneity in sourcing outside of NAFTA

- Heterogeneity in sourcing outside of NAFTA could be driven by:
  - Differences in countries' sourcing attractiveness
  - Differences in the fixed costs of sourcing

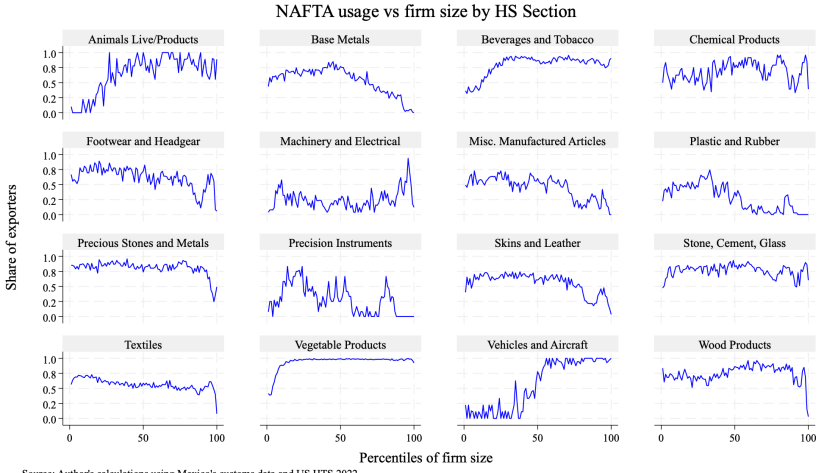


NAFTA usage has been constant over time

- Around 75% of firms export using NAFTA
- Firms use NAFTA to export equally as often whether they are exporting to the USA or Canada
- Share of firms using NAFTA is constant over time, exhibiting some degree of seasonality, likely driven by the sectoral composition of exports

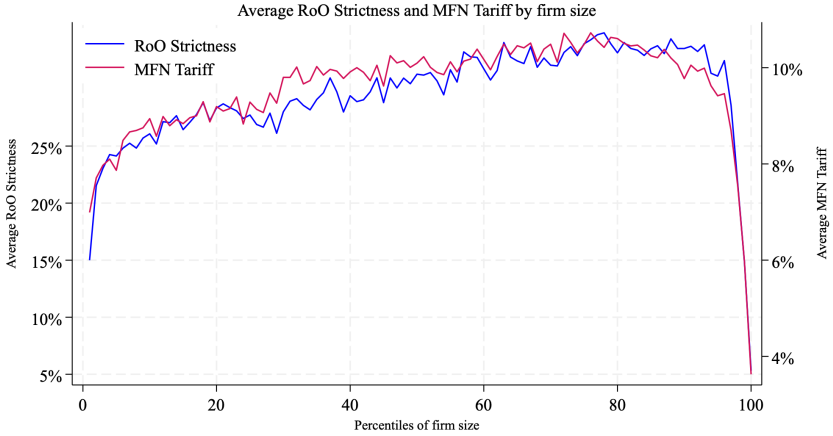


NAFTA usage and firm size by industry



Source: Author's calculations using Mexico's customs data and US HTS 2022.

Average RoO and MFN by firm size



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.

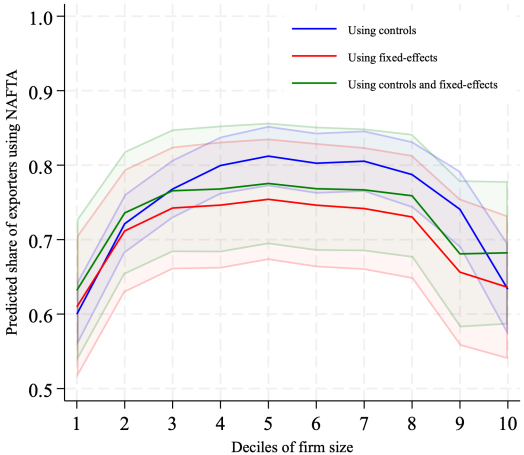
Back

NAFTA usage regression results and industry fixed-effects

Table: Probability of using NAFTA

	(1)	(2)
d2	0.122***	0.102***
	(7.26)	(3.97)
d3	0.168***	0.133***
	(8.41)	(4.22)
d4	0.200***	0.137***
	(9.68)	(4.01)
d5	0.212***	0.145***
	(10.01)	(4.34)
d6	0.203***	0.137***
	(9.37)	(4.00)
d7	0.206***	0.132***
	(9.55)	(3.86)
d8	0.188***	0.121***
	(8.25)	(3.40)
d9	0.141***	0.0467
	(5.49)	(1.03)
d10	0.0336	0.0263
	(1.07)	(0.53)
RoO Strictness	-0.00184***	
	(-4.74)	
MFN Tariff	0.00580**	
	(3.02)	
Constant	0.600***	0.610***
	(27.45)	(20.98)
HS Chapter F.E.	✗	✓
Observations	103,917	163,111

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Prediction shows the estimated coefficients controlling either for the effect of RoO and MFN Tariffs, or including HS Chapter fixed-effects. Colored areas show the 95% confidence interval. Standard errors are clustered at the firm-level.

Alternative definitions of firm size

Table: Probability of using NAFTA

	(1)	(2)	(3)	(4)
Size percentile	0.0102***	0.00659***		
	(11.37)	(7.52)		
Percentile sq	-0.0000982***	-0.0000584***		
	(-10.75)	(-7.65)		
RoO Strictness	-0.00186***		-0.00198***	
	(-4.78)		(-5.09)	
MFN Tariff	0.00557**		0.00563**	
	(2.91)		(2.94)	
Log of exports			0.153***	0.0881***
			(10.18)	(6.56)
Log of exports sq			-0.00663***	-0.00379***
			(-9.46)	(-6.01)
Constant	0.565***	0.673***	-0.0925	0.320***
	(24.30)	(30.14)	(-1.17)	(4.40)
HS Chapter F.E.	✗	✓	✗	✓
Observations	103,917	70,785	103,917	70,785

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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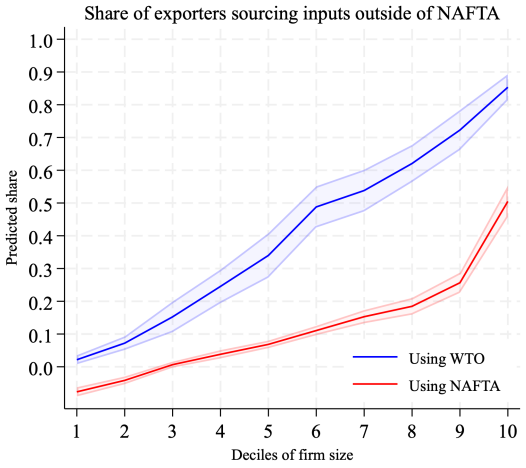
Non-NAFTA sourcing regression results

Table: Probability of Non-NAFTA sourcing

	(1) Firms using WTO	(2) Firms using NAFTA
2nd decile	0.0507*** (4.89)	0.0351*** (6.64)
3rd deciles	0.131*** (5.46)	0.0830*** (11.07)
4th decile	0.224*** (8.43)	0.115*** (11.50)
5th decile	0.318*** (9.02)	0.145*** (13.94)
6th decile	0.467*** (14.03)	0.187*** (15.74)
7th decile	0.517*** (15.12)	0.229*** (15.38)
8th decile	0.599*** (19.42)	0.261*** (15.09)
9th decile	0.701*** (21.55)	0.333*** (16.80)
10th decile	0.832*** (38.05)	0.581*** (21.94)
Constant	0.0215** (3.06)	-0.0765*** (-10.63)
HS Chapter F.E.	✓	✓
Observations	13,542	57,209

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Prediction shows the estimated coefficients controlling for HS Chapter fixed-effects. Colored areas show the 95% confidence interval. Standard errors are clustered at the firm-level.

Alternative definitions of firm size

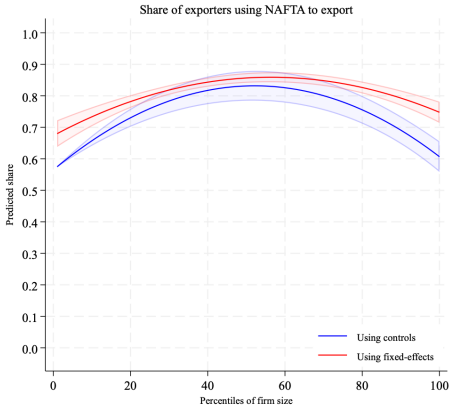
Table: Probability of Non-NAFTA sourcing

	(1) Firms using WTO	(2) Firms using NAFTA	(3) Firms using WTO	(4) Firms using NAFTA
Size percentile	0.0118***	-0.000312		
	(9.84)	(-0.27)		
Percentile sq	-0.0000239*	0.0000604***		
	(-1.99)	(4.55)		
Log of exports			0.110***	-0.0948***
			(6.41)	(-4.86)
Log of exports sq			-0.000688	0.00747***
			(-0.93)	(7.28)
Constant	-0.000222	-0.0159	-0.645***	0.237**
	(-0.01)	(-0.90)	(-7.11)	(2.65)
HS Chapter F.E.	✓	✓	✓	✓
Observations	47,056	112,964	47,056	112,964

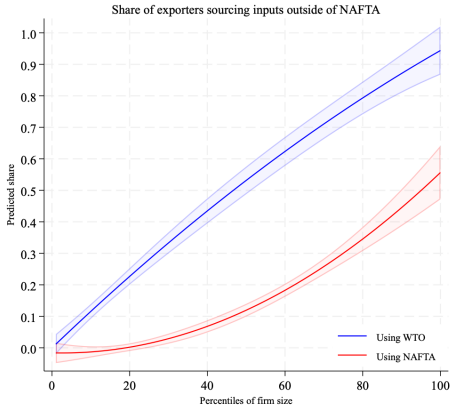
t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Using a quadratic form for percentiles of firm size

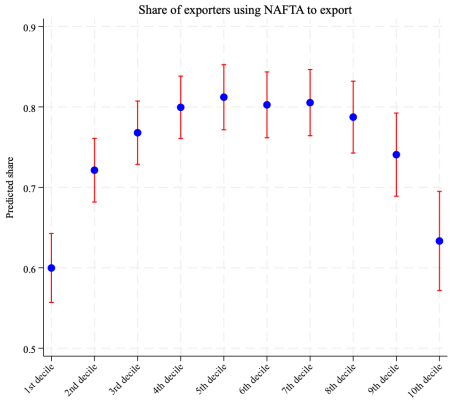


Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Prediction shows the estimated coefficients controlling either for the effect of RoO and MFN Tariffs, or including HS Chapter fixed-effects. Colored areas show the 95% confidence interval. Standard errors are clustered at the firm-level.

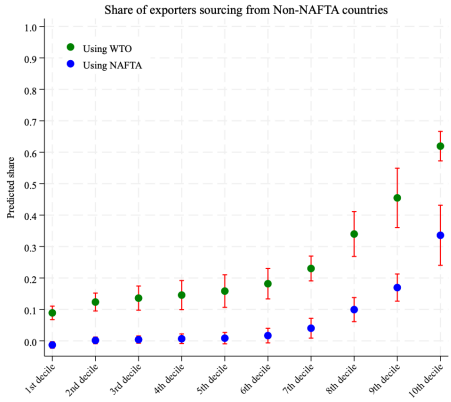


Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Prediction shows the estimated coefficients controlling for HS Chapter fixed-effects. Colored areas show the 95% confidence interval. Standard errors are clustered at the firm-level.

Results when defining size deciles within HS Chapters



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level.



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level.

Back

Evidence of Fixed Costs

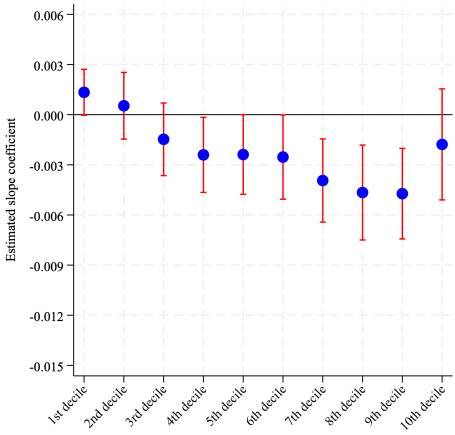
- Effects of RoO and MFN Tariffs should be heterogeneous across firm sizes
- Regress the probability of using NAFTA against interactions with firm size:

$$\mathbb{N}_{ikjt} = \beta_1 + \sum_{k=2}^{10} \beta_k \mathbb{I}_{ikt} + \alpha_1 \text{ROO}_j + \sum_{k=2}^{10} \alpha_k \mathbb{I}_{ikt} \times \text{ROO}_j + \gamma_1 \text{MFN}_j + \sum_{k=2}^{10} \gamma_k \mathbb{I}_{ikt} \times \text{MFN}_j + \iota_t + \epsilon_{ikjt}$$

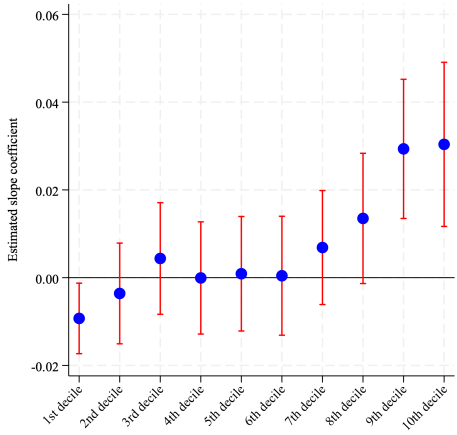
- Stronger marginal effects for larger firms $\Rightarrow$ evidence of fixed costs
  - Absolute value of $\alpha_1 + \alpha_k$ and $\gamma_1 + \gamma_k$ should be increasing in $k \geq 2$

i: firm; k: decile; j: product; t: month ι: fixed-effects

Marginal Effects on the Probability of Using NAFTA

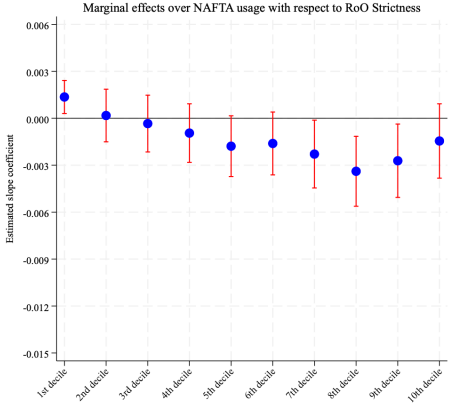


(c) Rules of Origin

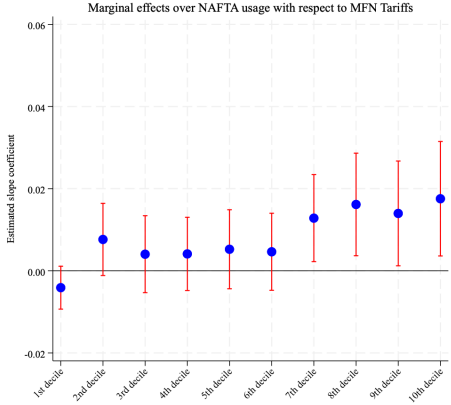


(d) MFN Tariffs

Results when defining size deciles within HS Chapters



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level.



Source: Author's calculations using Mexico's customs data, BEA's 1997 IO Tables, NAFTA's Annex 401, and US HTS 2022.
Note: Red intervals indicate the 95% confidence interval. Standard errors are clustered at the firm-level.

Back

Demand in the US

- Demand faced by the firm of variety ω:

$$q_{si}(\omega) = \frac{\alpha_s \eta E P_{si}^{\sigma-\epsilon}}{\sum_k P_{sk}^{1-\epsilon}} p_{si}(\omega)^{-\sigma}$$

- $P_{si}^{1-\sigma} \equiv \int_0^1 p_{si}(\omega)^{1-\sigma} d\omega$ is the Dixit-Stiglitz ideal price index

- α_s is the share of expenditure in sector s from total expenditure in imports:

$$\sum_s \alpha_s = 1$$

Back

s: sector; i, k: industry

Input shares from each sourcing location

- Share of inputs firm ϕ purchases from a Non-NAFTA country:

$$x_{si}^{j}(\phi,\kappa,\lambda,J) = (1-\kappa\lambda)\frac{\overbrace{T_{si}^{j}(d^{j}w_{si}^{j})^{-\theta}}^{\text{Sourcing potential of } j}}{\sum_{h\in J} T_{si}^{h}(d^{h}w_{si}^{h})^{-\theta}}$$

- Share of inputs sourced from a NAFTA country:

$$x_{si}^{j}(\phi,\kappa,\lambda,J) = \kappa\lambda\frac{T_{si}^{j}(d^{j}w_{si}^{j})^{-\theta}}{\sum_{h\in N\cap J} T_{si}^{h}(d^{h}w_{si}^{h})^{-\theta}} + (1-\kappa\lambda)\frac{T_{si}^{j}(d^{j}w_{si}^{j})^{-\theta}}{\sum_{h\in J} T_{si}^{h}(d^{h}w_{si}^{h})^{-\theta}}$$

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s: sector; i: industry; j, h: country; $\kappa = 1$: NAFTA

Firm operating profits and market demand

- Operating profits for a given κ and J:

$$\pi_{si}(\phi,\kappa,\lambda,\tau) = \phi^{\sigma-1}\gamma^{(\sigma-1)/\theta}B_{si}[1+(1-\kappa)\tau]^{1-\sigma}[\kappa\lambda\Psi_{si}(\phi)^{(\rho-1)/\theta}+(1-\kappa\lambda)\Phi_{si}(\phi)^{(\rho-1)/\theta}]^{\frac{1-\sigma}{1-\rho}}$$

- B_{si} is US market demand:

$$B_{si} = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left[\frac{\alpha_s \eta E P_{si}^{\sigma-\epsilon}}{\sum_k P_{sk}^{1-\epsilon}}\right]$$

s: sector; i, k: industry; $\kappa = 1$: NAFTA; ρ: Substitution Parameter; θ: Fréchet Distribution

Partial equilibrium

- Assume wages w are exogenous and firms must pay δ to start exporting
- Prices of varieties $p_{si}(\omega)$ and wages w are such that:
  1. Consumers maximize utility by choosing $q_{si}(\omega)$
  2. Firms maximize profits by choosing J^* and κ^* given $\{\lambda, \tau, f, \zeta\}$
  3. Firms meet demand for their variety
  4. Expected profits of exporting to the USA are zero, which yields:

$$N_{si} = \frac{\alpha_s \eta E[1 - G(\tilde{\phi}_{si})]}{\sigma w \left[\delta + \int_{\tilde{\phi}_{si}}^{\infty} \left(\kappa(\phi)\zeta_{si} + \sum_{j \in J(\phi)} f_{si}^{j}(\phi)\right) dG(\phi)\right]} \times \frac{P_{si}^{1-\epsilon}}{\sum_k P_{sk}^{1-\epsilon}}$$

$G(\cdot)$: Pareto cdf; $\tilde{\phi}_{si}$: lowest productivity that chooses to enter

Comparative Statics

- For simplicity, if there were no fixed cost of using NAFTA or fixed costs of sourcing, a firm would choose to export using NAFTA if:

$$(1+\tau)\Phi^{-\frac{1}{\theta}} > \left[\lambda\Psi^{\frac{\rho-1}{\theta}} + (1-\lambda)\Phi^{\frac{\rho-1}{\theta}}\right]^{\frac{1}{1-\rho}}$$

  The benefit of using NAFTA, avoid paying the MFN tariff, is larger than the cost of using NAFTA, the increase in marginal cost because of RoO

- Note that if there are no fixed costs, then Ψ and Φ are constant as firms will always include all countries in their sourcing strategy. For convenience, we can rewrite the above as:

$$\frac{1-(1+\tau)^{1-\rho}}{\lambda} > 1 - \left(\frac{\Psi}{\Phi}\right)^{\frac{\rho-1}{\theta}}$$

Comparative Statics

1. NAFTA usage is decreasing in RoO: the derivative of the RHS is 0 while that of the LHS is negative given that $\rho > 1$

$$-\frac{[1-(1+\tau)^{1-\rho}]}{\lambda^2} < 0$$

2. NAFTA usage is increasing in the MFN tariff: the derivative of the RHS is 0 while that of the LHS is positive

$$\frac{\rho-1}{\lambda}(1+\tau)^{-\rho} > 0$$

An increase in RoO should increase the opportunity cost of using NAFTA, while an increase in MFN Tariffs increases the benefit from using it

Comparative Statics

3. NAFTA usage is increasing in the sourcing potential of NAFTA countries: the derivative of the LHS is 0 while that of the RHS is negative given that $\Phi > \Psi$

$$\frac{1-\rho}{\theta}\left(\frac{\Psi}{\Phi}\right)^{\frac{\rho-1}{\theta}-1}\left[\frac{\Phi-\Psi}{\Phi^2}\right] < 0$$

4. NAFTA usage is decreasing in the sourcing potential of non-NAFTA countries: the derivative of the LHS is 0 while that of the RHS is positive

$$\frac{1-\rho}{\theta}\left(\frac{\Psi}{\Phi}\right)^{\frac{\rho-1}{\theta}-1}\left[-\frac{\Psi}{\Phi^2}\right] > 0$$

Comparative Statics

5. NAFTA usage is decreasing in the fixed cost of using NAFTA to export

6. NAFTA usage is increasing in the fixed cost of sourcing from a foreign country

    - Φ is weakly decreasing in fixed costs of sourcing; if these increase, the ability to source outside of NAFTA decreases, thus the opportunity cost of using NAFTA decreases.

When we allow for fixed cost of using NAFTA and fixed costs of sourcing from foreign countries, the results above do not necessarily hold. For example:

- If the sourcing potential of NAFTA countries increases, then revenue increases as marginal cost goes down
- This increase might give firms enough revenue to be able to source from a foreign country and then the firm would no longer choose to use NAFTA

Comparative Statics

7. Parameter θ plays a key role in determining the responsiveness of NAFTA usage with respect to changes in RoO

   - θ is the shape parameter of the Fréchet distribution for a country's unit labor costs of producing an input
   - Higher values of $\theta \Rightarrow$ less variability in unit labor costs $\Rightarrow$ less comparative advantage across countries $\Rightarrow$ firms don't care as much for RoO
   - Lower values of $\theta \Rightarrow$ more variability in unit labor costs $\Rightarrow$ stronger comparative advantage across countries $\Rightarrow$ RoO play a larger role

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Parametrization

- We take several parameters from the literature:

Parameter	Description	Value	Source
σ	Elasticity across final goods	3.85	Antrás et al. (2017)
ϵ	Elasticity across industries	3.00	Broda and Weinstein (2006)
θ	Fréchet distribution	1.79	Antrás et al. (2017)
κ	Pareto distribution	4.25	Melitz and Redding (2015)

- We set $\rho = 1.05 \rightarrow$ inputs are complementary in production

Sourcing potentials

- For a firm either using WTO to export or facing no RoO, input share for j is:

$$x_{si}^{j}(\phi) = \frac{T_{si}^{j}(d^{j}w_{si}^{j})^{-\theta}}{\sum_{h \in J} T_{si}^{h}(d^{h}w_{si}^{h})^{-\theta}}$$

- Normalizing Mexico's sourcing potential to one and taking the ratio:

$$\ln x_{si}^{j}(\phi) - \ln x_{si}^{MEX}(\phi) = \ln T_{si}^{j}(d_{j}w_{si}^{j})^{-\theta} + \epsilon_{si}^{j}(\phi) \text{ for } j = \text{NAFTA, CHN, EUR, ROW}$$

- Regress observed log-difference on industry-country fixed-effects

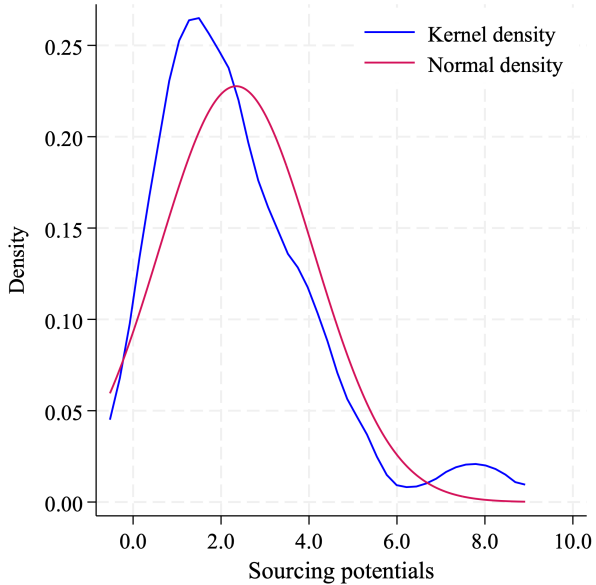
s: sector; i: industry; j, h: country

Sourcing potentials

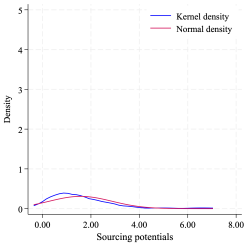
- We use IO Tables and our firm-level data for the estimation, assuming that if an input is not imported, it is sourced entirely from Mexico, and vice versa
- We estimate these sourcing potentials at the HS 2-digit level, using variation at the 6-digit level
  - Estimates are at the exporting sector-country level, i.e. how good is a given sector at country j at supplying intermediate inputs
- We then use IO Tables again to infer the sourcing potential of country j specific to an importing sector, i.e. given the inputs a given sector uses, how attractive it is to a Mexican firm in it to source from j
  - E.g. if China has a sourcing potential of 0.8 in A and 0.2 in B and a sector uses 60% of A and 40% of B, then China's sourcing potential specific to this sector is 0.56

Estimated sourcing potentials

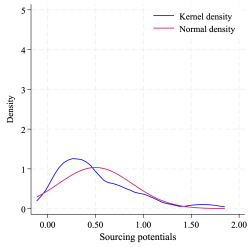
- Average estimated sourcing potential of US-CA is 1.55, of China is 0.49, of Europe is 0.24, and of ROW is 0.03
- Lowest potential sourcing capability is for *Preparations of meat, or fish, or crustaceans* (13%)
- Highest potential sourcing capability is for *Plastics and articles thereof* (826%)



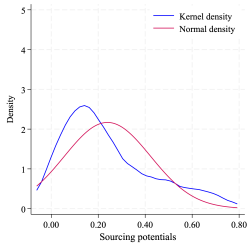
Estimated sourcing potentials by country



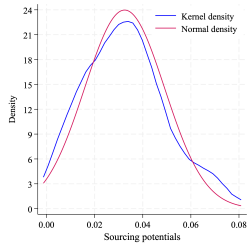
(e) US-CA



(f) China

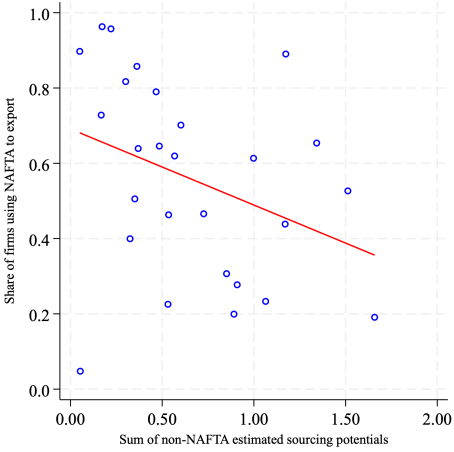


(g) Europe

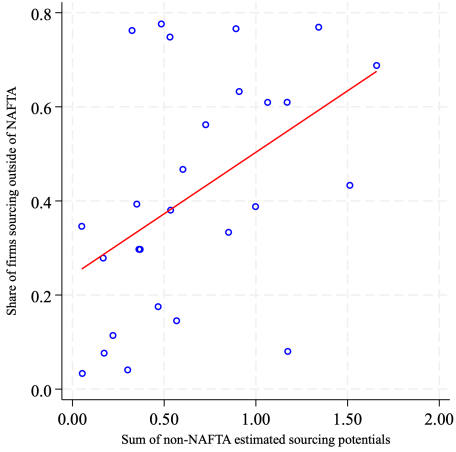


(h) ROW

Correlation with NAFTA usage and Non-NAFTA sourcing



(i) NAFTA usage



(j) Non-NAFTA sourcing

Industry-level sourcing potentials

HS Chapter	Description	Sector	HS Section	SP US-CA	SP China	SP Europe	SP ROW	Total SP
02	Meat	1	1	0.15	0.03	0.02	0.01	0.21
03	Fish and crustaceans	1	1	0.38	0.18	0.06	0.06	0.68
04	Dairy Produce, Eggs, Natural Honey	1	1	0.87	0.26	0.14	0.02	1.29
06	Live trees and other plants	2	1	0.89	0.53	0.63	0.02	2.07
07	Edible vegetables	2	1	0.25	0.10	0.07	0.04	0.47
08	Edible fruits and nuts	2	1	0.22	0.09	0.05	0.03	0.40
16	Preparations of meat, or fish, or crustaceans	4	1	0.08	0.02	0.02	0.01	0.13
17	Sugars and sugar confectionery	4	1	1.58	0.61	0.38	0.02	2.58
18	Cocoa and cocoa preparations	4	1	2.21	0.87	0.56	0.01	3.65
19	Preparations of cereals, flour, starch or milk	4	1	0.95	0.34	0.20	0.03	1.52
20	Preparations of vegetables, fruit, or nuts	4	1	0.22	0.09	0.05	0.03	0.39
21	Miscellaneous edible preparations	4	1	0.64	0.22	0.12	0.03	1.00
32	Tanning or dyeing extracts	6	2	3.23	0.51	0.29	0.05	4.08
33	Essential oils and resinoids, perfumery, cosmetics	6	2	1.40	0.38	0.17	0.04	2.00
36	Explosibes, pyrothehnic products	6	2	0.53	0.18	0.08	0.03	0.82
39	Plastics and articles thereof	7	2	6.60	1.08	0.57	0.01	8.26
40	Rubber and articles thereof	7	2	2.39	0.62	0.26	0.02	3.30
42	Articles of leather	8	3	1.84	0.61	0.37	0.02	2.84
43	Furskins and artificial fur	8	3	0.96	0.40	0.14	0.03	1.53
44	Wood and articles of wood	9	3	1.00	0.22	0.12	0.03	1.38
46	Manufactures of straw, esparto or other plaiting materials	9	3	0.80	0.27	0.12	0.03	1.22
56	Wadding, felt and nonwovens, special yarns, ropes	11	3	3.39	1.04	0.43	0.02	4.88
61	Articles of appareal and clothing accessories, knitted	11	3	2.20	0.91	0.22	0.04	3.37
62	Articles of appareal and clothing accessories, not knitted	11	3	2.20	0.92	0.22	0.04	3.38
63	Other made up textile articles	11	3	3.00	1.11	0.39	0.01	4.52
64	Footwear, gaiters and the like	12	3	1.77	0.59	0.41	0.01	2.78
65	Headgear and parts thereof	12	3	2.12	0.76	0.23	0.04	3.15
66	Umbrellas, walking sticks, whips	12	3	1.44	0.29	0.14	0.04	1.91
67	Prepared feathers and down articles	12	3	1.44	0.29	0.14	0.04	1.91
69	Ceramic products	13	4	2.33	1.53	0.71	0.02	4.58
70	Glass and glassware	13	4	4.86	1.71	0.65	0.01	7.23
71	Precious stones, precious metals	14	4	0.58	0.28	0.14	0.05	1.04
73	Articles of iron or steel	15	4	0.89	0.21	0.10	0.04	1.24
76	Aluminum and articles thereof	15	4	0.74	0.14	0.07	0.05	1.00
83	Mischellaneous articles of base metal	15	4	0.87	0.22	0.10	0.04	1.24
84	Nuclear reactors, boilers, machinery and mechanical appliances	16	5	0.60	0.19	0.07	0.07	0.92
85	Electrical machinery and equipment and parts thereof	16	5	1.02	0.33	0.13	0.07	1.55
87	Vehicles other than railway or tramway	17	5	0.83	0.30	0.12	0.06	1.31
90	Optical, photographic, precision, medical apparatus	18	5	2.23	0.56	0.27	0.06	3.12
91	Clocks and watches and parts thereof	18	5	0.87	0.81	0.48	0.05	2.22
92	Musical instruments	18	5	1.40	0.29	0.14	0.04	1.86
94	Furniture, bedding, mattresses, cushions, lamps	20	6	1.68	0.49	0.19	0.04	2.41
95	Toys, games and sports requisites	20	6	3.18	0.66	0.38	0.03	4.25
96	Miscellaneous manufactured articles	20	6	1.57	0.33	0.17	0.04	2.11
Average				1.55	0.49	0.24	0.03	2.31
Maximum				6.60	1.71	0.71	0.07	8.26
Minimum				0.08	0.02	0.02	0.01	0.13

Table: Industry-level Sourcing Potentials by Foreign Country.

Simulated Method of Moments

- We estimate the following parameters for **each sector individually**:
  - Fixed cost of using NAFTA: ζ_s
  - Fixed costs of sourcing from each country: μ_s^j $\rightarrow f_s^j \overset{\text{iid}}{\sim} \text{lognormal}(\mu_s^j, \sqrt{log(2)})$
  - US market demand: B_s

- Moments used to estimate these parameters are:
  - Share of firms using NAFTA to export
  - Share of firms sourcing inputs from each country
  - Average firm-level exports

- We also include the following moments:
  - Share of firms using NAFTA to export by quintile of size $\rightarrow$ EF 2
  - Share of firms sourcing outside of NAFTA by quintile of size $\rightarrow$ EF 3

Estimated parameters

	ζ_s	μ_s^{CHN}	μ_s^{EUR}	μ_s^{NAF}	μ_s^{OTH}	B_s
Agriculture and Foods	0.001	-3.490	-3.681	-3.216	-3.718	0.007
Minerals and Chemicals	0.002	-4.101	-4.707	-3.185	-4.292	0.009
Skins and Textiles	0.003	-4.513	-4.614	-3.599	-4.227	0.007
Mining	0.000	-5.943	-6.443	-4.143	-5.443	0.000
Manufactures	1.687	0.657	-0.243	1.935	0.535	1.566
Others	0.004	-5.304	-5.604	-3.504	-4.901	0.002

ζ: fixed cost of NAFTA; f: fixed cost of sourcing; B: US market demand

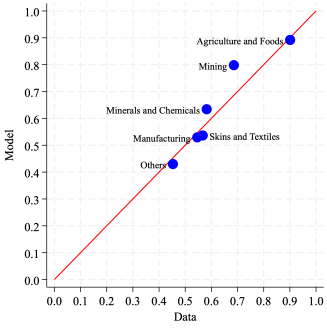
Estimation results

- Average fixed costs f as a share of exports X, and market demand:

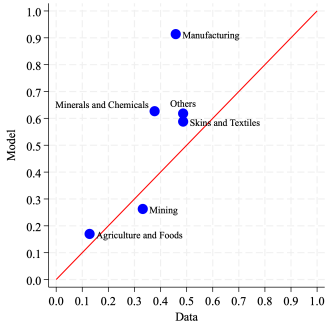
	ζ_s/X	f_s^{CHN}/X	f_s^{EUR}/X	f_s^{NAF}/X	f_s^{ROW}/X	B_s
Agriculture and Foods	0.54	20.15	16.66	26.51	16.04	0.45
Minerals and Chemicals	0.43	5.15	2.81	12.88	4.26	0.60
Skins and Textiles	0.62	3.40	3.07	8.48	4.52	0.47
Mining	0.04	5.28	3.20	31.96	8.71	0.01
Manufacturing	1.08	1.75	0.71	6.28	1.55	100.00
Others	1.50	2.78	2.06	16.8	4.15	0.13
Average	0.70	6.42	4.75	17.15	6.54	16.94

ζ: fixed cost of NAFTA; f: fixed cost of sourcing; B: US market demand

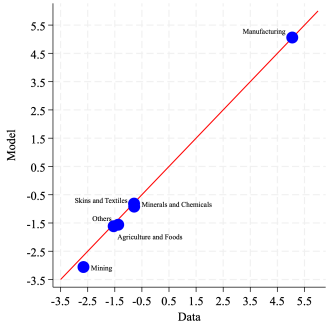
Sectoral NAFTA usage, non-NAFTA sourcing, and Exports



(k) NAFTA usage

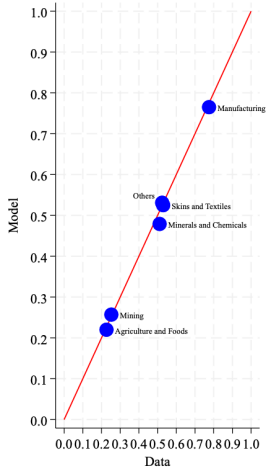


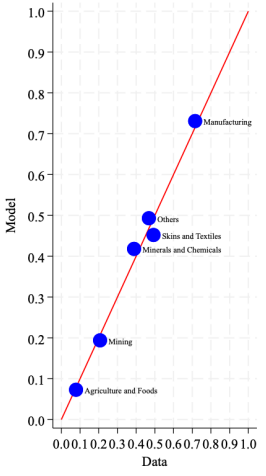
(l) Non-NAFTA Sourcing

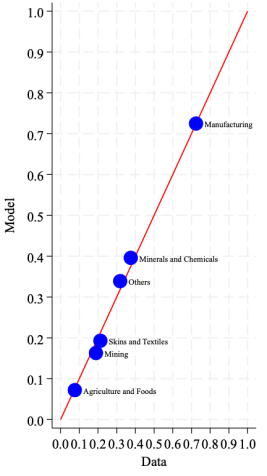


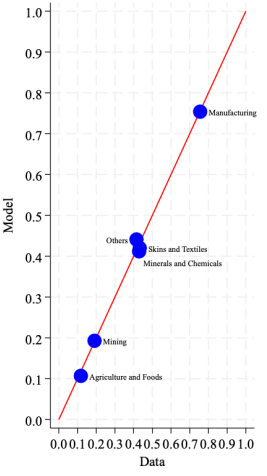
(m) Log Exports

Sectoral Entry Rates

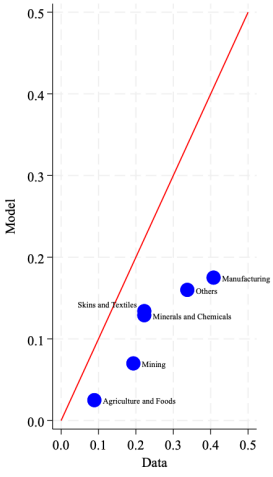


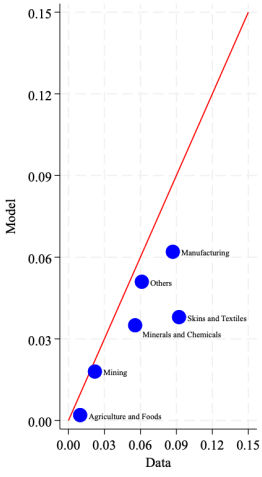


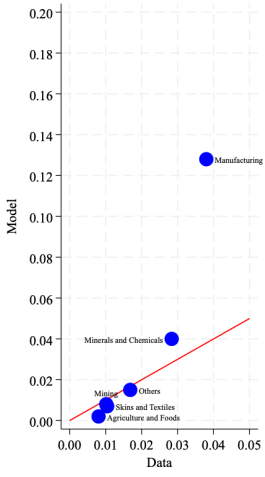


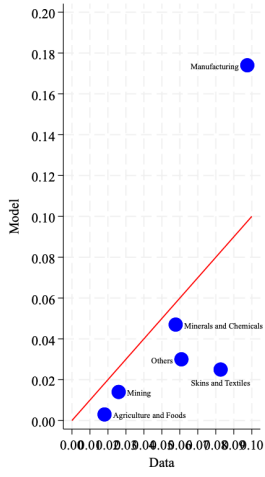


Sectoral Input Shares

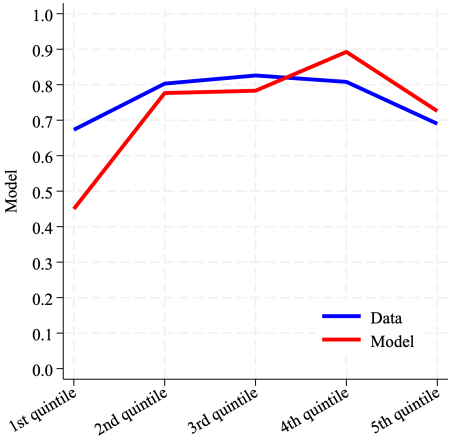




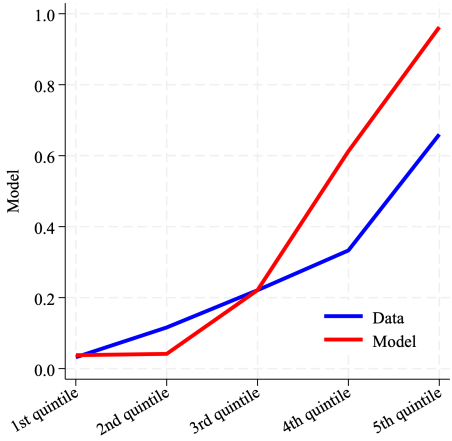




Fit of the model



(n) NAFTA to export



(o) Non-NAFTA Sourcing

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Counterfactual 2: Increase in Tariffs

- All Mexican exports pay at least a 5% ad-valorem tariff
- Change, in percentage terms, in key variables for the USA and Mexico:

	US-CA Exports of inputs to MX	US-CA Price index for MX imports	MX firm profits
Agriculture and Foods	-17.04	4.86	-13.42
Minerals and Chemicals	-15.07	5.58	-13.92
Skins and Textiles	-12.04	4.16	-8.95
Mining	-13.53	5.74	-14.82
Manufacturing	-12.15	4.79	-11.25
Others	-12.05	4.57	-7.74
Average	-13.65	4.95	-11.68

Counterfactual 2: Increase in Tariffs

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.47	0.00	0.21	0.32	-
	Change				
Share of firms sourcing from China	0.63	0.00	-0.21	-2.14	p.p. Δ
Share of firms sourcing from Europe	-0.50	0.00	-0.11	-1.97	p.p. Δ
Share of firms sourcing from US-CA	-5.15	0.00	-0.31	-2.71	p.p. Δ
Share of firms sourcing from ROW	0.62	0.00	-0.22	-2.32	p.p. Δ
Share of inputs coming from US-CA	-3.09	0.00	-0.08	-0.83	p.p. Δ
Average Marginal Cost	10.20	0.00	0.62	6.23	% Δ
Average Exports	-13.36	0.00	-5.68	-13.95	% Δ

Counterfactual 3: NAFTA without RoO

- Set all RoO to zero, but keep MFN Tariffs and fixed cost of using NAFTA
- Change, in percentage terms, in key variables for the USA and Mexico:

	US-CA Exports of inputs to MX	US-CA Price index for MX imports	MX firm profits
Agriculture and Foods	1.89	-1.41	4.32
Minerals and Chemicals	0.33	-0.19	0.97
Skins and Textiles	12.44	-3.50	21.34
Mining	0.10	-0.26	0.35
Manufactures	0.19	-0.14	0.34
Others	2.93	-1.36	5.82
Average	2.98	-1.15	5.52

Counterfactual 3: NAFTA without RoO

	NAFTA to WTO	WTO to NAFTA	Stayed WTO	Stayed NAFTA	Units
Share of firms	0.00	0.09	0.12	0.79	-
			Change		
Share of firms sourcing from China	0.00	6.56	0.00	6.17	p.p. Δ
Share of firms sourcing from Europe	0.00	7.33	0.00	3.05	p.p. Δ
Share of firms sourcing from US-CA	0.00	8.67	0.00	0.38	p.p. Δ
Share of firms sourcing from ROW	0.00	6.34	0.00	6.29	p.p. Δ
Share of inputs coming from US-CA	0.00	2.43	0.00	-1.37	p.p. Δ
Average Marginal Cost	0.00	-25.43	0.00	-2.10	% Δ
Average Exports	0.00	21.57	0.00	0.84	% Δ

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